FORMS PTO-1390 (REV 10-96) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
SI01-015	
U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	
10/031900	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/02398	July 21, 2000	July 21, 1999

TITLE OF INVENTION

OPTICAL COUPLING DEVICE

APPLICANT(S) FOR DO/EO/US

Corning Incorporated

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C.371.
3. ☐ This express request to being national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. To 16. Below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: - Original Translation of PCT Application
    -Version of Application With Markings to Show Changes Made
    -**CLEAN** Version of Amended Application, to be used for examination purposes

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/031900 | INTERNATIONAL APPLICATION NO.: PCT/DE00/02398 | ATTORNEY'S DOCKET NUMBER: SI01-015

17. ☒ The following fees are submitted:

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a)(1)-(5):	
Neither international preliminary examination fee (37 DFR 1.482) nor international search fee (37 CFR 1 445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO **$740.00**	
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33 (1)-(4) **$710.00**	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	18 ~~19~~ - 20 =	0	X $18.00	$.00
Independent claims	2 - 3 =	0	X $84.00	$.00
MULTIPLE DEPENDANT CLAIM(S) (if applicable)			+ $270.00	$

TOTAL OF ABOVE CALCULATIONS =	$890.00
Reduction of ½ for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) +	$
SUBTOTAL =	$890.00
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +	$
TOTAL NATIONAL FEE =	$890.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +	$
TOTAL FEES ENCLOSED =	$.00
Amount to be refunded:	$
Charged:	**$890.00**

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated below and is Addressed to the Commissioner of Patents and Trademarks, Washington, DC 20231

on 1/19/02 (Date) By: Bethany Beligotti Signature Bethany Beligotti

"EXPRESS MAIL" Mailing Label No. EV060836365US

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☒ Corning Incorporated hereby authorizes use of **Deposit Account No. 03-3325** in the amount of $ 890.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 03-3325. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
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Walter M. Douglas
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SI01-015

#3/a

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: Gerhard Heise et al.

Serial No: TBA

Art Group Unit: TBA

Filing Date: Herewith

Examiner: TBA

Title: OPTICAL COUPLING DEVICE

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

After receipt of the application and prior to the calculation of the filing fees for the application, applicants respectfully request the entry of this amendment.

The Commissioner is hereby authorized to changes any fees due for the filing of this application or the entry of this amendment to Deposit Account No. 03-3325

Prior to examination of the above captioned application and issuing an office action on the merits, please enter this amendment, as set forth below.

IN THE SPECIFICATION

Please see attached application entitled "Clean Version of Amended Application".

IN THE CLAIMS

Please see attached application entitled "Clean Version of Amended Application".

REMARKS

This application is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000, which was filed in the German language, and which claimed the priority of German Application No. 19934179.6. Enclosed herewith please find a copy of the application translated into English as received from the translating party, entitled "Original Translation". Also enclosed please find a copy of the application as amended with additions underlined and deletions in brackets, which application is entitled "Version of Application with Markings to Show Changes Made". Finally, enclosed please find a clean copy of the application as amended, entitled "Clean Copy of Amended Application". Applicants enclose copies of the complete application to show the changes made and a clean copy of the complete application because under the new rules, we would have had to replace almost every paragraph in the application in this Preliminary Amendment. Applicants believe that no new subject matter has been added to the application.

Applicants respectfully that all amendments made herein be duly entered into the application. If there are any question, please contact applicants' undersigned attorney.

Conclusion

Based upon the above amendments and remarks, Applicants believe the pending claims of the above-captioned application are in allowable form and patentable. Applicants respectfully request consideration of the application as amended and a prompt Notice of Allowance thereon.

Applicants believe that no extension of time is necessary to file this Preliminary Amendment. Should Applicants be mistaken, Applicants respectfully request that the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this amendment timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Walter M. Douglas at (607) 974-2431.

Respectfully submitted,

CORNING INCORPORATED

Date: Jan 18, 2002

Walter M. Douglas
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Date of Deposit: 1/19/02

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date indicated above with sufficient postage as first class mail in an envelope addressed to the: Commissioner of Patents and Trademarks, Washington, DC 20231

Signature Bethany Beligotti

CLEAN VERSION OF AMENDED APPLICATION

SI01-015

OPTICAL COUPLING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of German Patent Application No. 19934179.6, filed July 21, 1999, and is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000.

FIELD OF THE INVENTION

[0002] The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide.

BACKGROUND OF THE INVENTION

[0003] Coupling devices for cross-coupling light from a first optical waveguide into a second optical waveguide have been disclosed; for example in WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face by which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operations (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

[0004] In known coupling devices, the fibres are adhesively bonded into V grooves and the cavities which are produced in the process are filled with adhesive. Since the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element,

stresses may occur in the adhesive under changing environmental conditions, and therefore the fibres may go out of adjustment or alignment.

SUMMARY OF THE INVENTION

[0005] In one aspect, the invention provides an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip or planar waveguide) is achieved with high reliability and stability and cost-effective mounting. This is achieved by an optical coupling device having the features specified in Patent Claim 1.

[0006] One advantageous configuration of the coupling device according to the invention is that a ferrule is inserted into a hole in the variable-length element.

[0007] In the coupling device cited in the introduction, a first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

[0008] For this purpose, one advantageous configuration of the optical coupling device according to the invention is that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

[0009] This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that mal-adjustment in other dimensions virtually does not occur.

[0010] A further advantageous configuration of the device according to the invention is that the guide device has a ferrule which is connected to the variable-length element, and is mounted in a hole in the second holding block such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this

case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

[0011] A further advantageous configuration of the device according to the invention is that the guide device has a ferrule which is connected to the second holding block, and is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

[0012] In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule, which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

[0013] A further advantageous configuration of the device according to the invention is that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

[0014] A further advantageous configuration of the device according to the invention is that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

[0015] A further advantageous configuration of the device according to the invention is that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Exemplary embodiments of the invention will be explained below using the drawings, in which:

[0017] Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

[0018] Fig. 2 shows a side view of the device according to Fig. 1; and

[0019] Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

[0020] Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

[0021] Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0022] Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0023] Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] A rectangular, elongate, variable-length element 2, made of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

[0025] A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°, in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

[0026] Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

[0027] Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip (planar waveguide) in this example.

[0028] At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

[0029] In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second optical waveguide 50, an optical waveguide chip in this example.

[0030] Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

[0031] In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

[0032] At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore

engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

[0033] In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

[0034] Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.

Patent Claims PCT Amended Sheets

1. Optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide, said device comprising:

an elongate, variable length element which extends with its longitudinal direction parallel to the optical waveguide end faces, a first holding element, which is arranged at one longitudinal end of the variable-length element and is fixed there to a unit containing the second optical waveguide and on which the variable-length element is supported at the end, a second holding element which is arranged at the other longitudinal end of the variable-length element and is fixed there to the unit containing the second optical waveguide and supports the variable-length element at its other end with respect to the second optical waveguide, a linear guide device being provided on the second holding element, by means of which linear guide device the variable-length element is guided at its other end in such a way that it can lengthen substantially only in the direction of its longitudinal axis, and a ferrule, in which the first optical waveguide is held and which is held on the variable-length element at a point between the two holding elements, so that the relative position of the two optical waveguide end faces in relation to one another can be influenced with the aid of the variable-length element.

2. The device according to Claim 1, wherein the ferrule is inserted into a hole in the variable-length element.

3. The device according to Claim 1, wherein the guide device has a ferrule which is connected to the variable-length element and which is mounted in a hole in the second holding element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

4. The device according to Claim 3, wherein the ferrule is guided in the second holding element via a sleeve.

5. The device according to Claim 1, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the

variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

6. The device according to Claim 2, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

7. The device according to Claim 5, wherein the ferrule is guided in the variable-length element via a sleeve.

8. The device according to Claim 6, wherein the ferrule is guided in the variable-length element via a sleeve.

9. The device according to Claim 1, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

10. The device according to Claim 2, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

11. The device according to Claim 1, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

12. The device according to Claim 2, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

13. The device according to Claim 1, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

14. The device according to Claim 2, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

15. The device according to Claim 11, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

16. The device according to Claim 12, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

17. An optical coupling device for cross-coupling light between a first waveguide and a second waveguide, each having end faces, said device comprising:

a second planar waveguide having a first and a second holding block thereon,

a variable-length element having an opening therethrough for a ferrule or sleeve into which a first fibre waveguide may be placed and held, said variable-length element being movingly mounted on said first and second holding blocks in such a manner that the variable-length element is only longitudinally moveable parallel to the second waveguide, and

optionally, a fastening element on said second holding block whereby the position of the variable-length element may be secured;

wherein the end faces of said first and second waveguide are held by said coupling devices in facial contact with one another.

18. The device according to claim 17, wherein said variable-length element has a plurality of openings to thereby hold a plurality of first waveguides in facial contact with a second waveguide.

Abstract of the Invention

The optical coupling device serves to cross-couple light from a first into a second optical waveguide, a variable-length element influencing the relative position of the opposite end faces of the two optical waveguides in relation to one another. The element that fixes one of the two optical waveguides in a ferrule is connected by a first holding block to a unit containing the other optical waveguide. The said element has a guide device which engages in a second holding block and permits the element to lengthen substantially only in a spatial direction oriented parallel to the longitudinal axis of the element.

VERSION OF APPLICATION WITH MARKINGS TO SHOW CHANGES MADE
SI01-015

OPTICAL COUPLING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of German Patent Application No. 19934179.6, filed July 21, 1999, and is a national stage filing under 35 U.S.C. § 371 of PCT Application No. PCT/DE00/02398, filed July 21, 2000.

FIELD OF THE INVENTION

[0002] The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide. [Such a coupling device is known, for example, from WO 98/13718.]

BACKGROUND OF THE INVENTION

[0003] Coupling devices for cross-coupling light from a first optical waveguide into a second optical waveguide have been disclosed; for example in WO 98/13718. Such coupling devices are used in optical filters according to the phased-array principle with an injection face by which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operations (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

[0004] In known coupling devices, the fibres are adhesively bonded into V grooves and [it] the cavities which are produced in the process are filled with adhesive. Since the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element,

stresses may occur in the adhesive under changing environmental conditions, and therefore [deadjustment of] the fibres may go out of adjustment or alignment.

SUMMARY OF THE INVENTION

[0005] [The object of] In one aspect, the invention [is to] provides an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip or planar waveguide) is achieved with high reliability and stability and cost-effective mounting. This [object] is achieved by an optical coupling device having the features specified in Patent Claim 1.

[0006] One advantageous configuration of the coupling device according to the invention is [characterized in] that [the] a ferrule is inserted into a hole in the variable-length element.

[0007] In the coupling device cited in the introduction, [the] a first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

[0008] For this purpose, one advantageous configuration of the optical coupling device according to the invention is [characterized in] that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

[0009] This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that [deadjustment] mal-adjustment in other dimensions virtually does not occur.

[0010] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device has a ferrule which is connected to the variable-length element, and [which] is mounted in a hole in the second holding block such that it can be

displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

[0011] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device has a ferrule which is connected to the second holding block, and [which] is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

[0012] In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule, which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

[0013] A further advantageous configuration of the device according to the invention is [characterized in] that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

[0014] A further advantageous configuration of the device according to the invention is [characterized in] that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

[0015] A further advantageous configuration of the device according to the invention is [characterized in] that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Exemplary embodiments of the invention will be explained below using the drawings, in which:

[0017] Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

[0018] Fig. 2 shows a side view of the device according to Fig. 1; and

[0019] Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

[0020] Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

[0021] Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0022] Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

[0023] Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0024] A rectangular, elongate, variable-length element 2, [consisting] made of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

[0025] A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°, in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

[0026] Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

[0027] Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip (planar waveguide) in this example.

[0028] At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

[0029] In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second optical waveguide 50, an optical waveguide chip in this example.

[0030] Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

[0031] In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

[0032] At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore

engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

[0033] In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

[0034] Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.

DELETE WHOLE PAGE. SEE PCT AMENDED SHEETS FOR AMENDED CLAIMS

[Patent Claims]

[1. Optical coupling device for cross-coupling light from a first optical waveguide (20) into a second optical waveguide (30), it being possible to influence the relative position of the two optical waveguide end faces in relation to each other with the aid of a variable-length element (2, 26, 46, 66, 86) that holds the first optical waveguide (20) in a ferrule (6, 24, 44, 64, 84), and the variable-length element (2, 26, 46, 66, 86) being fixed to a unit containing the second optical waveguide (30) via a first holding element (4, 28, 48) and having a guide device (38, 40) which permits the element (2, 26, 46, 66, 86) to lengthen only in a spatial direction oriented substantially parallel to the longitudinal axis of the element.]

[2. Device according to Claim 1, characterized in that the ferrule (6, 24, 44, 64, 84) is inserted into a hole in the variable-length element (2, 26, 46, 66, 86).]

[3. Device according to one of the preceding claims, characterized in that the guide device has a second holding element (40, 58, 74) as an abutment, on which the variable-length element (26, 46, 66, 86) is guided parallel to the expansion direction of the variable-length element.]

[4. Device according to Claim 3, characterized in that the guide device has a ferrule (36) which is connected to the variable-length element (26) and which is mounted in a hole in the second holding element (40) such that it can be displaced in the direction of the axis of the variable-length element (26) in which the variation in length takes place.]

[5. Device according to Claim 4, characterized in that the ferrule is guided in the second holding element (40) via a sleeve (38).]

[6. Device according to Claim 3, characterized in that the guide device has a ferrule which is connected to the second holding element (40) and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.]

[7. Device according to Claim 6, characterized in that the ferrule is guided in the variable-length element via a sleeve.]

[8. Device according to Claim 3, characterized in that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element (58).]

[9. Device according to Claim 3, characterized in that the second holding block (74) has a U-shaped cross section, and in that the variable-length element (56) is guided in the U-shaped cross section of the second holding element (74).]

[10. Device according to Claim 3, characterized in that an abutment (92), which engages on the second optical waveguide in a displaceable manner, is fixed to the variable-length element (86).]

[11. Device according to Claim 8, characterized in that the abutment has on one side a spring (96) between one end of the abutment and the second optical waveguide (90) and on the other side a setting screw (100) between another end of the abutment and the second optical waveguide (90).]

Patent Claims PCT Amended Sheets

1. Optical coupling device for cross-coupling light from a first optical waveguide [(20, 42, 62, 82)] into a second optical waveguide [(30, 50, 70, 90)], [having] said device comprising:

an elongate, variable length element [(26, 46, 66, 86)] which extends with its longitudinal direction parallel to the optical waveguide end faces, a first holding element [(28, 48, 68, 88)], which is arranged at one longitudinal end of the variable-length element [(26, 46, 66, 86)] and is fixed there to a unit containing the second optical waveguide [(30, 50, 70, 90)] and on which the variable-length element [(26, 46, 66, 86)] is supported at the end, a second holding element [(40, 58, 74, 92)] which is arranged at the other longitudinal end of the variable-length element [(26, 46, 66, 86)] and is fixed there to the unit containing the second optical waveguide [(30, 50, 70, 90)] and supports the variable-length element [(26, 46, 66, 86)] at its other end with respect to the second optical waveguide [(30, 50, 70, 90)], a linear guide device being provided on the second holding element [(40, 58, 74, 92)], by means of which linear guide device the variable-length element [(26, 46, 66, 86)] is guided at its other end in such a way that it can lengthen substantially only in the direction of its longitudinal axis, and a ferrule [(24, 44, 64, 84)], in which the first optical waveguide [(20, 42, 62, 82)] is held and which is held on the variable-length element [(26, 46, 66, 86)] at a point between the two holding elements [(28, 48, 68, 88; 40, 58, 74, 92)], so that the relative position of the two optical waveguide end faces in relation to one another can be influenced with the aid of the variable-length element [(26, 46, 66, 86)].

2. [Device] The device according to Claim 1, [characterized in that] wherein the ferrule [(24, 44, 64, 84)] is inserted into a hole in the variable-length element [(26, 46, 66, 86)].

3. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device has a ferrule [(36)] which is connected to the variable-length element [(26)] and which is mounted in a hole in the second holding element [(40)] such that it

can be displaced in the direction of the axis of the variable-length element [(26)] in which the variation in length takes place.

4. [Device] The device according to Claim 3, [characterized in that] wherein the ferrule is guided in the second holding element [(40)] via a sleeve [(38)].

5. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device has a ferrule which is connected to the second holding element [(40)] and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

6. The device according to Claim 2, wherein the guide device has a ferrule which is connected to the second holding element and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

7. [Device] The device according to Claim 5, [characterized in that] wherein the ferrule is guided in the variable-length element via a sleeve.

8. The device according to Claim 6, wherein the ferrule is guided in the variable-length element via a sleeve.

9. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element [(58)].

10. The device according to Claim 2, wherein the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element.

11. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the second holding element [(74)] has a U-shaped cross section, and in that the variable-length element [(56)] is guided in the U-shaped cross section of the second holding element [(74)].

12. The device according to Claim 2, wherein the second holding element has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding element.

13. [Device] The device according to Claim 1 [or 2], [characterized in that] wherein the variable-length element [(86)] is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

14. The device according to Claim 2, wherein the variable-length element is connected firmly to the second holding element, and in that the second holding element acts on the second optical waveguide in a displaceable manner.

15. [Device] The device according to Claim [8] 11, [characterized in that] wherein the second holding element has, on one side, a spring [(96)] between its end and the second optical waveguide [(90)] and, on the other side, a setting screw [(100)] between its other end and the second optical waveguide [(90)].

16. The device according to Claim 12, wherein the second holding element has, on one side, a spring between its end and the second optical waveguide and, on the other side, a setting screw between its other end and the second optical waveguide.

17. An optical coupling device for cross-coupling light between a first waveguide and a second waveguide, each having end faces, said device comprising:

a second planar waveguide having a first and a second holding block thereon,

a variable-length element having an opening therethrough for a ferrule or sleeve into which a first fibre waveguide may be placed and held, said variable-length element being

movingly mounted on said first and second holding blocks in such a manner that the variable-length element is only longitudinally moveable parallel to the second waveguide, and

optionally, a fastening element on said second holding block whereby the position of the variable-length element may be secured;

wherein the end faces of said first and second waveguide are held by said coupling devices in facial contact with one another.

18. The device according to claim 17, wherein said variable-length element has a plurality of openings to thereby hold a plurality of first waveguides in facial contact with a second waveguide.

Abstract of the Invention

[Optical coupling device]

The optical coupling device serves to cross-couple light from a first into a second optical waveguide [(20, 30)], a variable-length element [(26)] influencing the relative position of the opposite end faces of the two optical waveguides [(20, 30)] in relation to one another. The element [(26)] that fixes one of the two optical waveguides [(20)] in a ferrule [(24)] is connected by a first holding block [(28)] to a unit containing the other optical waveguide [(30)]. The said element has a guide device [(34, 36)] which engages in a second holding block [(38, 40)] and permits the element [(26)] to lengthen substantially only in a spatial direction oriented parallel to the longitudinal axis of the element.

[Figure 4]

Original Translation

Description

Optical coupling device

The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide. Such a coupling device is known, for example, from WO 98/13718.

Such coupling devices are used in optical filters according to the phased-array principle with an injection face which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

In known coupling devices, the fibres are adhesively bonded into V grooves and it cavities which are produced in the process are filled with adhesive. Since

the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element, stresses may occur in the adhesive under changing environmental conditions, and therefore deadjustment of the fibres.

The object of the invention is to provide an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip) is achieved with high reliability and stability and cost-effective mounting. This object is achieved by an optical coupling device having the features specified in Patent Claim 1.

One advantageous configuration of the coupling device according to the invention is characterized in that the ferrule is inserted into a hole in the variable-length element.

In the coupling device cited in the introduction, the first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

For this purpose, one advantageous configuration of the optical coupling device according to the invention is characterized in that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that deadjustment in other dimensions virtually does not occur.

A further advantageous configuration of the device according to the invention is characterized in that the guide device has a ferrule which is connected to the variable-length element and which is mounted in a hole in the second holding block such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

A further advantageous configuration of the device according to the invention is characterized in that the guide device has a ferrule which is connected to the second holding block and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule,

which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

A further advantageous configuration of the device according to the invention is characterized in that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

A further advantageous configuration of the device according to the invention is characterized in that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

A further advantageous configuration of the device according to the invention is characterized in that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

Exemplary embodiments of the invention will be explained below using the drawings, in which:

Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

Fig. 2 shows a side view of the device according to Fig. 1; and

Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

A rectangular, elongate, variable-length element 2, consisting of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°,

in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip in this example.

At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second

optical waveguide 50, an optical waveguide chip in this example.

Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross

section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.

Patent Claims

1. Optical coupling device for cross-coupling light from a first optical waveguide (20) into a second optical waveguide (30), it being possible to influence the relative position of the two optical waveguide end faces in relation to each other with the aid of a variable-length element (2, 26, 46, 66, 86) that holds the first optical waveguide (20) in a ferrule (6, 24, 44, 64, 84), and the variable-length element (2, 26, 46, 66, 86) being fixed to a unit containing the second optical waveguide (30) via a first holding element (4, 28, 48) and having a guide device (38, 40) which permits the element (2, 26, 46, 66, 86) to lengthen only in a spatial direction oriented substantially parallel to the longitudinal axis of the element.

2. Device according to Claim 1, characterized in that the ferrule (6, 24, 44, 64, 84) is inserted into a hole in the variable-length element (2, 26, 46, 66, 86).

3. Device according to one of the preceding claims, characterized in that the guide device has a second holding element (40, 58, 74) as an abutment, on which the variable-length element (26, 46, 66, 86) is guided parallel to the expansion direction of the variable-length element.

4. Device according to Claim 3, characterized in that the guide device has a ferrule (36) which is connected to the variable-length element (26) and which is mounted in a hole in the second holding element (40) such that it can be displaced in the direction of the axis of the variable-length

element (26) in which the variation in length takes place.

5. Device according to Claim 4, characterized in that the ferrule is guided in the second holding element (40) via a sleeve (38).

6. Device according to Claim 3, characterized in that the guide device has a ferrule which is connected to the second holding element (40) and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place.

7. Device according to Claim 6, characterized in that the ferrule is guided in the variable-length element via a sleeve.

8. Device according to Claim 3, characterized in that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding element (58).

9. Device according to Claim 3, characterized in that the second holding block (74) has a U-shaped cross section, and in that the variable-length element (56) is guided in the U-shaped cross section of the second holding element (74).

10. Device according to Claim 3, characterized in that an abutment (92), which engages on the second optical waveguide in a displaceable manner, is fixed to the variable-length element (86).

11. Device according to Claim 8, characterized in that the abutment has on one side a spring (96) between one end of the abutment and the second optical waveguide (90) and on the other side a setting

screw (100) between another end of the abutment and the second optical waveguide (90).

Abstract

1. Optical coupling device

2. The optical coupling device serves to cross-couple light from a first into a second optical waveguide (20, 30), a variable-length element (26) influencing the relative position of the opposite end faces of the two optical waveguides (20, 30) in relation to one another. The element (26) that fixes one of the two optical waveguides (20) in a ferrule (24) is connected by a first holding block (28) to a unit containing the other optical waveguide (30). The said element has a guide device (34, 36) which engages in a second holding block (38, 40) and permits the element (26) to lengthen substantially only in a spatial direction oriented parallel to the longitudinal axis of the element.

3. Figure 4

FIG 1

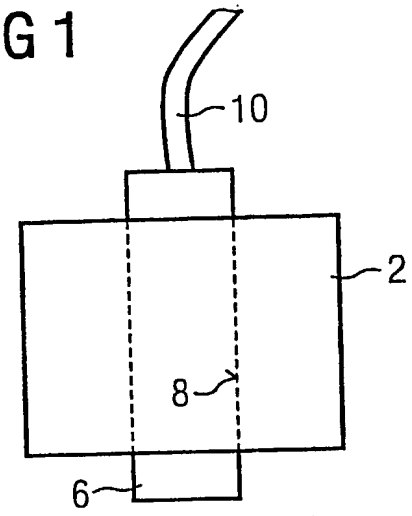


FIG 2

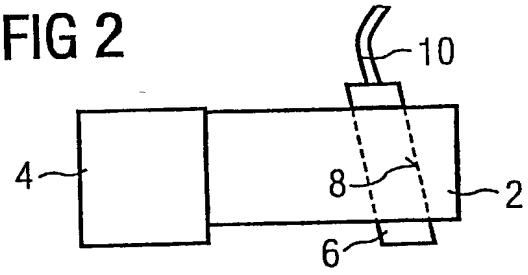


FIG 3

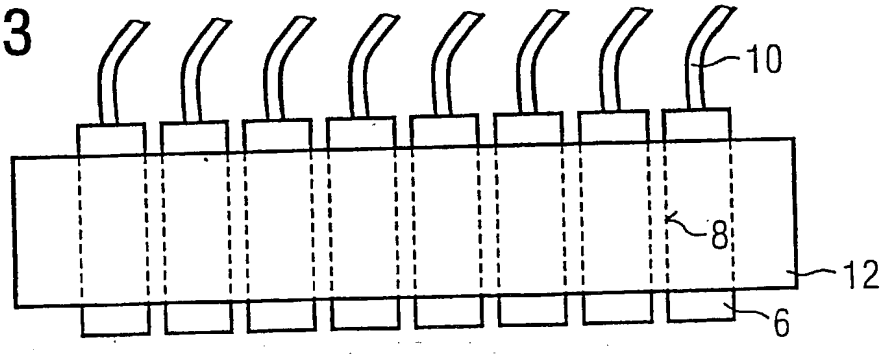


FIG 4A

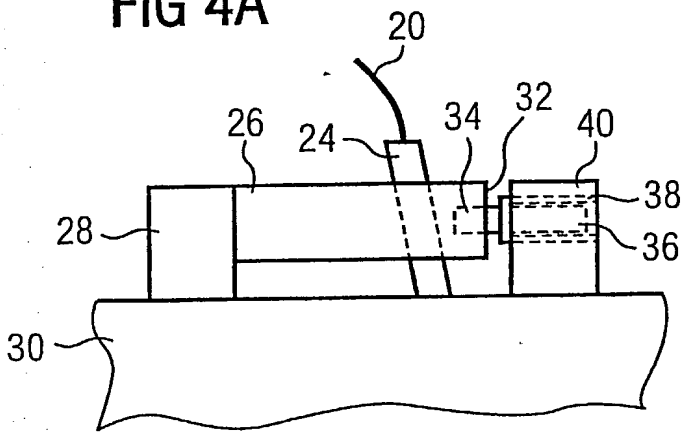


FIG 4B

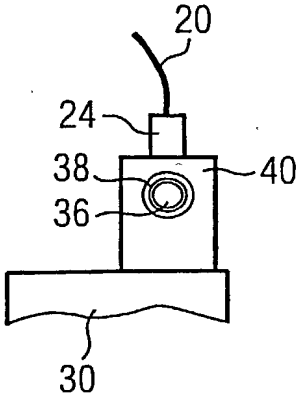


FIG 5A

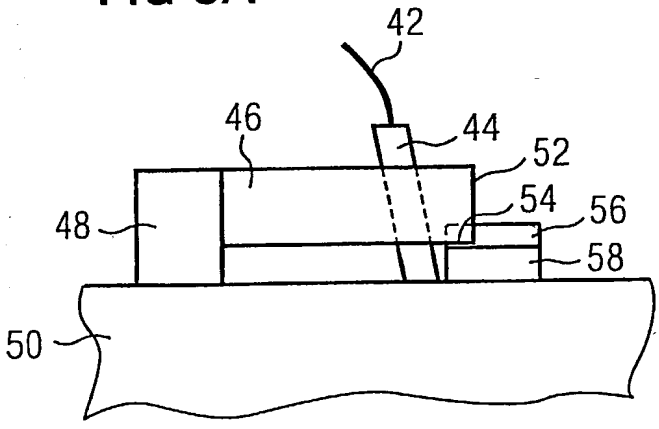


FIG 5B

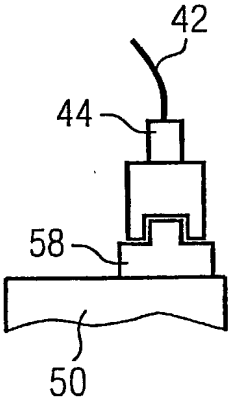


FIG 6A

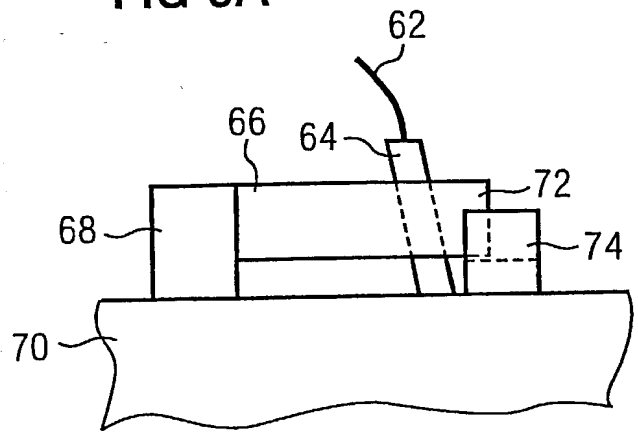


FIG 6B

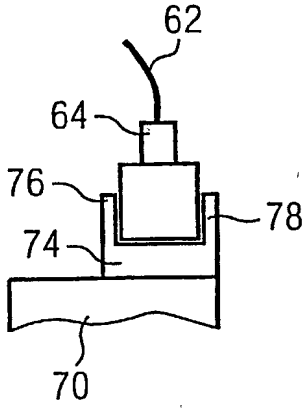


FIG 7A

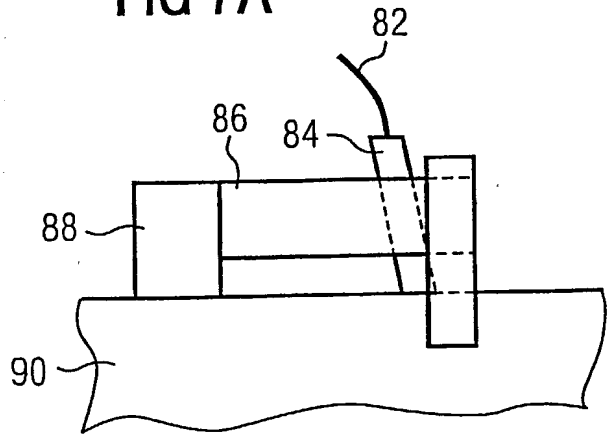
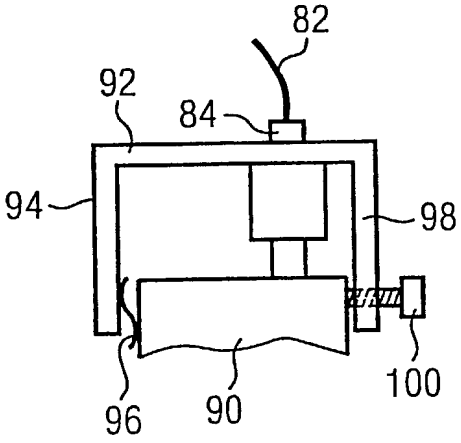


FIG 7B



#5

DECLARATION IN ORIGINAL APPLICATION **U.S. Attorney Docket No.: SI01-015**

As a below named inventor, I declare that:

My residence, Post Office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **OPTICAL COUPLING DEVICE**.

The specification of which (check only one item below):

☐ is attached hereto

☒ was filed as United States Application Serial No. 10/031,900 on 1/19/02 and was amended on (if applicable)

☐ was filed as PCT international application number , on , and was amended under PCT Article 19 on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application which designated at least one country other than the Unites States, listed below and have also identified below any foreign application for patent or inventor's certificate, on the same subject matter, having a filing date before that of the application on which priority is claimed:

☒ **Country:** Germany **Application No.:** 19934179.6 **Filing Date:** 7/21/99

☐ **NONE**

I hereby claim the benefit under Title 35 United States Code § 119(e) and § 120 of any United States application(s) or 365(c) of any PCT international application designating the United States listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37 Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

☐	**Provisional No.:**	**Filed:**		**Status:**	
☒	**Application No.:**	**Filed:**		**Status:**	
	PCT Application No: DE00/02398	**Filed:**	7/21/00	**Status:**	Pending

☐ **NONE**

DECLARATION IN ORIGINAL APPLICATION **U.S. Attorney Docket No.: SI01-015**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

Full Name of Inventor: Wolfgang Schweiker

Resident Address: Im Goldenen Tal 6, 83629 Weyarn, Germany DEX
Post Office Address: same

Citizenship: German

DATE: 03/14/02 Wolfgang Schweiker

Wolfgang Schweiker

Full Name of Inventor: Mathias Kampf

Resident Address: Irlbrundlstr. 6, 93142 Maxhutte-Haidhof, Germany
Post Office Address: same

Citizenship: German

DATE: _____

Mathias Kampf

3-00

Full Name of Inventor: Gerhard Heise

Resident Address: Dajuwaren Weg 16, 85579 Neubiberg ~~Gustav-Heinemann-Ring 6, 81739 Munchen, Germany~~ DEX
Post Office Address: same

Citizenship: German

DATE: 04/15/2002 Gerhard Heise

Gerhard Heise

DECLARATION IN ORIGINAL APPLICATION U.S. Attorney Docket No.: SI01-015

As a below named inventor, I declare that:

My residence, Post Office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **OPTICAL COUPLING DEVICE**.

The specification of which (check only one item below):

☐ is attached hereto

☒ was filed as United States Application Serial No. 10/031,900 on 1/19/02 and was amended on (if applicable)

☐ was filed as PCT international application number , on , and was amended under PCT Article 19 on (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate or 365(a) of any PCT international application which designated at least one country other than the Unites States, listed below and have also identified below any foreign application for patent or inventor's certificate, on the same subject matter, having a filing date before that of the application on which priority is claimed:

☒ **Country:** Germany **Application No.:** 19934179.6 **Filing Date:** 7/21/99

☐ **NONE**

I hereby claim the benefit under Title 35 United States Code § 119(e) and § 120 of any United States application(s) or 365(c) of any PCT international application designating the United States listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37 Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

☐	**Provisional No.:**	**Filed:**		**Status:**	
☒	**Application No.:**	**Filed:**		**Status:**	
	PCT Application No:DE00/02398	**Filed:**	7/21/00	**Status:**	Pending

☐ **NONE**

DECLARATION IN ORIGINAL APPLICATION U.S. Attorney Docket No.: SI01-015

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Inventor: Wolfgang Schweiker

Resident Address: Im Goldenen Tal 6, 83629 Weyarn, Germany
Post Office Address: same

Citizenship: German

DATE:_____

_____
Wolfgang Schweiker

2-00

Full Name of Inventor: Mathias Kampf

Resident Address: Irlbründlstr. 6, 93142 Maxhütte-Haidhof, Germany DEX
Post Office Address: same

Citizenship: German

DATE: 04/24/2002

Mathias Kampf
Mathias Kampf

Full Name of Inventor: Gerhard Heise

Resident Address: Gustav-Heinemann-Ring 6, 81739 Munchen, Germany
Post Office Address: same

Citizenship: German

DATE:_____

_____
Gerhard Heise

(U.S.) Attorney Docket No.: **SI01-015**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Schweiker, et al	**COMBINED CERTIFICATE UNDER 37 C.F.R. § 3.73(b) and POWER OF ATTORNEY**
Serial No.:		
Filed:		
For:	OPTICAL COUPLING DEVICE	

Assistant Commissioner for Patents
Washington, DC 20231

CERTIFICATE UNDER 37 C.F.R. § 3.73(b)

CORNING INCORPORATED, a New York corporation, certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of an assignment from the inventor(s) of the patent application identified above. A true copy of the unrecorded Assignment is attached hereto.

The undersigned has reviewed the above referenced assignment of the patent application identified above and, to the best of the undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned is empowered to sign this certificate on behalf of the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

(U.S.) Attorney Docket No.: **SI01-015**

POWER OF ATTORNEY BY ASSIGNEE

CORNING INCORPORATED, the assignee of the full and exclusive right, title and interest in and to the accompanying application for United States Letters Patent entitled **OPTICAL COUPLING DEVICE** and executed by Wolfgang Schweiker, Mathias Kampf, Gerhard Heise, on March 14, 2002, April 24, 2002, April 15, 2002 respectively, appoints the practitioners associated with the Customer Number provided below (i.e., the practitioners associated with the Patent Department, Corning Incorporated) to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith. Please direct all correspondence to Walter M. Douglas at the address associated with that Customer Number.

Customer Number: 22928

CORNING INCORPORATED

Date: May 30, 2002

By _____
Mark W. Lauroesch
Assistant Secretary

Case Name: SI01-015

PATENT ASSIGNMENT COVER SHEET

To the Honorable Commissioner of Patents and Trademarks Please record the attached documents or copy thereof

(1) Conveying Party(ies): Wolfgang Schweiker
Mathias Kampf
Gerhard Heise

Title: OPTICAL COUPLING DEVICE

Additional name(s) of conveying party(ies) attached? *Yes* ☐ *No* ☒

(2) Receiving Party: Corning Incorporated
Patent Dept.; SP-TI-03-1
Corning, NY 14831

(3) Nature of conveyance: Assignment executed:

(4) Application number(s) and/or patent number(s) against which this assignment is to be recorded:

A. Patent Application No.(s): 10/031,900
Filing date: 1/19/02

B. Patent No.(s):
Filing date:

If this document is being filed together with a new application, this assignment is also to be recorded against said application, executed on ___.

(5) Name and address of party to whom correspondence concerning document should be mailed:

Name: Walter M. Douglas
Reg. No. 34,510
Corning Incorporated
Patent Department
SP-TI-03-1
Corning, NY 14831
Phone No.: (607) 974-2431

(6) Total Number of applications and/or patents involved: one

(7) Total Fee = $40.00

☐ Enclosed (Check No.)
☐ Included with filing fee. Check No. ____.
☒ Authorization given by Corning Incorporated to charge deposit account number 03-3325 (attached is a triplicate copy of this page)

To the best of my knowledge and belief, the foregoing information is true and correct and any attached copy is a true copy of the original document.

Walter M. Douglas

30 May 2002
Date

Total number of pages comprising cover sheet: 4

(U.S. Regular Application) Attorney Docket No.: **SI01-015**

ASSIGNMENT

FOR VALUE RECEIVED, I, as a below named inventor, hereby sell, assign and transfer unto Corning Incorporated, a corporation organized and existing under the laws of the State of New York, having its principal place of business at Corning, New York, (hereinafter CORNING), as assignee, and unto its successors, assigns and legal representatives, the entire right, title and interest, for all countries, in and to certain inventions relating to a **OPTICAL COUPLING DEVICE**, such inventions being generally described in an application as set forth in United States Patent Application Serial No. 10/031,900 filed 1/19/02, for Letters Patent of the United States executed on

DATE	March 14, 2002
DATE	April 24, 2002
DATE	April 15, 2002

and in any future patent applications claiming the benefit of the filing date of that application, and all the rights and privileges under any and all Letters Patents that may be granted therefore.

I request that any and all patents for said inventions be issued to CORNING, its successors, assigns and legal representatives, or to such nominees as CORNING may designate.

I agree that, when requested, I will, without charge to CORNING and at CORNING's expense, sign all papers, take all rightful oaths, and do all acts which may be necessary, desirable or convenient for securing and maintaining patents for said inventions in any and all countries and for vesting title thereto in CORNING, its successors, assigns and legal representatives or nominees.

I authorize and empower CORNING, its successors, assigns and legal representatives or nominees, to invoke and claim for any application for patent or other form of protection for said inventions filed by it or them, the benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for said Convention or entered as a supplement to, and to invoke and claim such right of priority without further written or oral authorization.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any assignment, consent to file or like document which may be required in any country for any purpose and more particularly in proof of the right of CORNING, or its successors, assigns and legal representatives or nominees to claim the aforesaid benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for it or entered as a supplement to it.

I covenant with CORNING, its successors, assigns and legal representatives or nominees, that the rights and property herein conveyed are free and clear of any encumbrance, and that I have full right to convey the same as herein expressed.

Signed:

03/14/02
Date

Wolfgang Schweiker

Date

Mathias Kampf

04/15/2002
Date

Gerhard Heise

On the 14 day of CB 2002, before me personally came **Wolfgang Schweiker** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness

On the 15th day of April 2002, before me personally came **Mathias Kampf** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness

On the 15th day of April 2002, before me personally came **Gerhard Heise** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness

(U.S. Regular Application) Attorney Docket No.: **SI01-015**

ASSIGNMENT

FOR VALUE RECEIVED, I, as a below named inventor, hereby sell, assign and transfer unto Corning Incorporated, a corporation organized and existing under the laws of the State of New York, having its principal place of business at Corning, New York, (hereinafter CORNING), as assignee, and unto its successors, assigns and legal representatives, the entire right, title and interest, for all countries, in and to certain inventions relating to a **OPTICAL COUPLING DEVICE**, such inventions being generally described in an application as set forth in United States Patent Application Serial No. 10/031,900 filed 1/19/02, for Letters Patent of the United States executed on

DATE	March 14, 2002
DATE	April 24, 2002
DATE	April 15, 2002

and in any future patent applications claiming the benefit of the filing date of that application, and all the rights and privileges under any and all Letters Patents that may be granted therefore.

I request that any and all patents for said inventions be issued to CORNING, its successors, assigns and legal representatives, or to such nominees as CORNING may designate.

I agree that, when requested, I will, without charge to CORNING and at CORNING's expense, sign all papers, take all rightful oaths, and do all acts which may be necessary, desirable or convenient for securing and maintaining patents for said inventions in any and all countries and for vesting title thereto in CORNING, its successors, assigns and legal representatives or nominees.

I authorize and empower CORNING, its successors, assigns and legal representatives or nominees, to invoke and claim for any application for patent or other form of protection for said inventions filed by it or them, the benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for said Convention or entered as a supplement to, and to invoke and claim such right of priority without further written or oral authorization.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any assignment, consent to file or like document which may be required in any country for any purpose and more particularly in proof of the right of CORNING, or its successors, assigns and legal representatives or nominees to claim the aforesaid benefit of the right of priority provided by the International Convention for the Protection of Industrial Property, as amended, or by any convention which may henceforth be substituted for it or entered as a supplement to it.

I covenant with CORNING, its successors, assigns and legal representatives or nominees, that the rights and property herein conveyed are free and clear of any encumbrance, and that I have full right to convey the same as herein expressed.

Signed:

Date	Wolfgang Schweiker
04/24/2002 Date	Mathias Kampf
Date	Gerhard Heise

On the _____ day of _____ 2002, before me personally came **Wolfgang Schweiker** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness

On the 24 day of April 2002, before me personally came **Mathias Kampf** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness

On the _____ day of _____ 2002, before me personally came **Gerhard Heise** known to be the person described in and who executed the foregoing instrument, and acknowledged that they executed the same.

Witness